



### Diagnosis Tool - Using Voltage as an Indicator UL Models

Chart One

UNDERSTANDING BATTERY VOLTAGES VERSUS STATE OF CHARGE AND THE BEHAVIOR OF LITHIUM ION BATTERIES AND THE BMS						
Lithionics Battery 1770 Calumet Street, Clearwater, Florida USA, 33765 727-726-4024 www.LithionicsBattery.com REV 04						
Per Cell	4-Cell or 12 Volt	8-Cell or 24 Volt	12-Cell or 36 Volt	15-Cell or 48 Volt	16-Cell or 51 Volt	Technical Notations UL1973 Compliant Systems. This Voltage Reading Generally Indicates:
<b>VALUES ASSOCIATED WITH BATTERIES AFTER CHARGING OR AFTER DISCHARGING HAS OCCURRED (ASSUMES NO LOAD PRESENT)</b>						
2.9	11.6	23.2	34.8	43.5	46.4	LVC or Low Voltage Cut-Off: when the battery reaches this voltage, the battery is completely depleted and charging is mandatory and should be performed expediently.
3	12	24	36	45	48	RVC or Reserve Voltage Cut-Off, AKA the NeverDie® Power Reserve. Normally set to preserve 10% of the battery energy to allow emergency "fuel". Re-charge ASAP. Ensure that your inverter Low Battery Cut-Out (LBCO) is set to a voltage slightly higher than the RVC cut-off voltage. This ensures that the inverters goes OFF, battery stays ON and able to accept a new charge cycle.
3.2	12.8	25.6	38.4	48	51.2	If a battery reads this voltage, it generally indicates the battery is at less than 30% state of charge.
3.3	13.2	26.4	39.6	49.5	52.8	If a battery reads this voltage, it can be anywhere from 30% to 80% state of charge. If the battery is below this voltage, state-of-charge can no longer be approximate due to the flat voltage curve with a rapid fall-off at the end.
3.33	13.32	26.64	39.96	49.95	53.28	Battery is above 80% state-of-charge.
3.4	13.6	27.2	40.8	51	54.4	Resting voltage of a fully charged battery <4 hours after charging. The time varies based on battery size and charging rates used.

Continued Page 2: Values Associated with Batteries During Charging Activities (Assume No Load Present)

# LITHIONICS BATTERY®

## LITHIUM-ION IRON PHOSPHATE BATTERY SYSTEMS

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Chart Two

VALUES ASSOCIATED WITH BATTERIES DURING CHARGING ACTIVITIES (ASSUMES NO LOAD PRESENT)						
3.35	13.4	26.8	40.2	50.25	53.6	FLOAT VALUE: if your charger has a Float Stage setting, set it to this value to maintain full charge. Charge will re-initiate when battery voltage falls below this value.
3.4	13.6	27.2	40.8	51	54.4	The average voltage of the battery during the bulk-charge stage, changing very little until state of charge reaches 80% or higher, due to the flat nature of the LiFePO4 voltage curve. Charger manufacturers should take note of this characteristic and ensure that their algorithm does not make any gassing assumptions that would alter the desired algorithm.
3.5	14	28	42	52.5	56	Typical "GEL" charging voltage, known to short-charge the batteries to 90 to 95% state of charge. A safe algorithm for lithium but it does not fully charge LiFePO4. When using this setting, increase ABSORB TIMES to 2 hours (typ.) to increase battery fill.
3.55	14.2	28.4	42.6	53.25	56.8	A safe "bulk" charging voltage for alternators with regulators (Balmar/Wakespeed*)
3.55	14.2	28.4	42.6	53.25	56.8	The CALIBRATION VOLTAGE that must be reached during charging to auto-adjust the State of Charge Meter Accuracy. Coloumb counting meters will drift during partial charge and discharge cycles and it is recommend to bring the batteries to a voltage at or higher than this voltage to re-calibrate SoC once per week.
3.6	14.4	28.8	43.2	54	57.6	The recommended charging voltage to ensure the battery is filled to >99% state-of-charge. Set ABSORB TIME to 30 Minutes (preferred). Some inverter-chargers may only offer a 1 Hour min. absorb time. A safe "bulk" charging voltage for alternators with regulators.*
3.65	14.6	29.2	43.8	54.75	58.4	The maximum charging voltage or charge-to voltage to ensure the battery is filled to 100% state of charge with minimum absorb times. Ensure ABSORB TIMES is set to under 30 minutes. Use this Setting for LITHIONICS APPROVED Chargers Only.
3.75	15	30	45	56.25	60	HVC or High Voltage Cut-Off: the maximum value per cell OR at pack voltage average that the BMS will disconnect from the charging source to ensure battery safety.

\*Contact Lithionics Battery® for approved voltage regulators and float settings for alternators. Most alternators are not regulated but are constant-voltage power supplies that require an ACR or Automatic Charge Relay.